

**MELANOTRICHUS BOYDI, A NEW SPECIES OF PLANT
BUG (HETEROPTERA: MIRIDAE: ORTHOTYLINI)
RESTRICTED TO THE NICKEL HYPERACCUMULATOR
STREPTANTHUS POLYGALOIDES (BRASSICACEAE)**

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Abstract.—*Melanotrichus boydi*, NEW SPECIES is described from the western foothills of the Sierra Nevada Mountains in California. The nickel hyperaccumulating species, *Streptanthus polygaloides* (Gray), Brassicaceae, an endemic to serpentine soils, is its only known host plant.

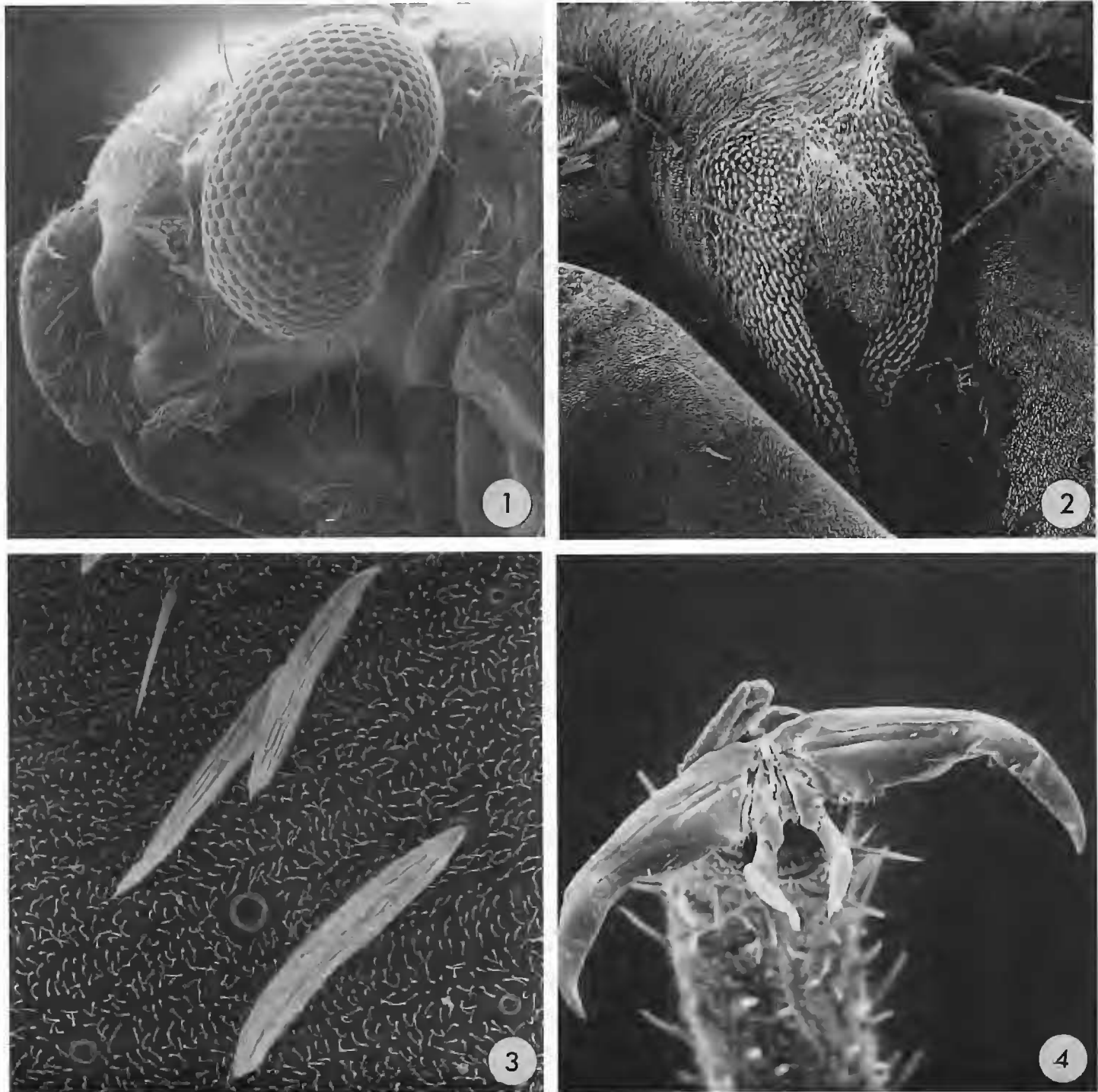
Key Words.—Insecta, Miridae, plant bugs, *Melanotrichus*, new species, nickel hyperaccumulators, serpentine soil.

As a consequence of its size, exceedingly diverse topography, climate, and geologic history, California supports a remarkably large and interesting flora (Munz & Keck 1973). Despite the pioneering work of E. P. Van Duzee and recent students of North American Miridae, the plant bug fauna of California is still poorly known. Current studies by the junior author in serpentine soil exposures of California have revealed a new species of plant bug restricted to a nickel hyperaccumulator species of crucifer. In this paper we describe *Melanotrichus boydi* Schwartz & Wall, NEW SPECIES, provide illustrations of the male genitalia, photomicrographs of the head, pretarsus, ostiolar peritreme, scalelike setae, a distribution map and discuss the first known example of bioaccumulation for a native herbivore on a metal hyperaccumulator. All measurements are based on ten specimens with the mean and range presented.

MELANOTRICHUS BOYDI Schwartz & Wall, New Species
(Figs. 1–14)

Types.—Holotype, male: U.S.A. CALIFORNIA. *ELDORADO Co.*: NE of Coloma, [900 m], 22 Jun 1998, M. A. Wall, ex *Streptanthus poly[galoides]*., M. Wall 98–105; deposited: California Academy of Sciences, San Francisco (CAS). Paratypes: 1♂, 1♀ same data as holotype except no host and M. Wall 1; *MARIPOSA Co.*: 1♂, 1♀ NW of Coulterville, [700 m], 23 Jun 1998, M. Wall (2); 3♂, 5♀ Lake McClure at hwy 49 [bridge], [900 m], 23 Jun 1998, M. Wall (9); 1♂, 5♀ NW of Mariposa, 29 Jun 1998, M. Wall (7); *PLACER Co.*: 1♂, 3♀ S of Sugar Pine Res[ervoir], [1270 m] 28 Jun 1998, M. A. Wall; *TUOLUMNE Co.*: 4♂, 4♀ S of Mocassin on hwy 49, [700 m], 11 Jun 1999, M. A. Wall; 4♂, 9♀ SW of Chinese Camp, Red Hills Rec Area, [470 m], 28 May 1999, M. A. Wall; 1♀ Chinese Camp, [470 m], 10 Jun 1997, M. A. Wall; 1♂ S of Chinese Camp in Red Hills Rec Area, [470 m], 9–13 Jun 1996, M. A. Wall. Paratypes deposited

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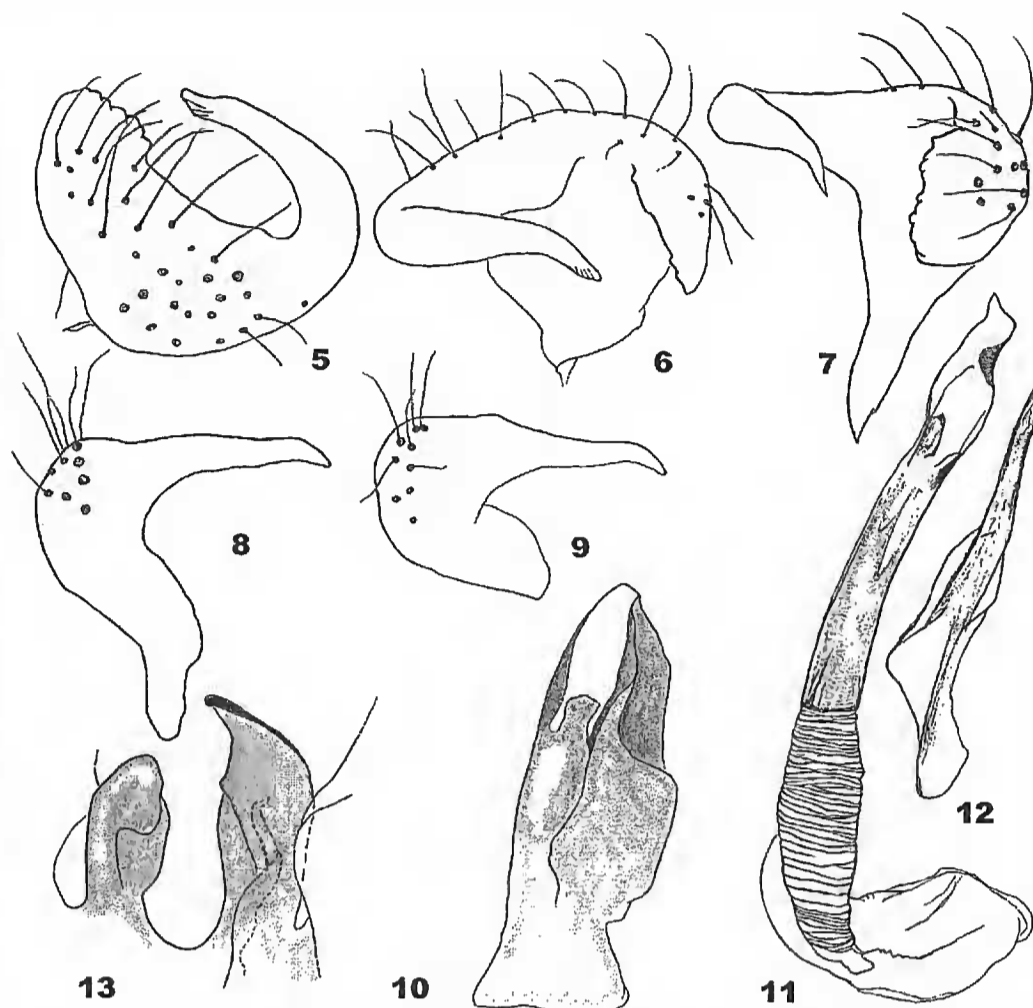


Figures 1–4. Scanning electron micrographs of *Melanotrachus boydi*. Figure 1. Head, lateral view. Figure 2. Ostiolar peritreme, lateral view. Figure 3. Scalelike setae on corium. Figure 4. Pretarsus, apical view.

at the American Museum of Natural History, New York, CAS, the Canadian National Collection of Insects, Ottawa and the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Description of Males.—Orthotylinae: Orthotylini. Length from clypeus to apex of membrane 5.74 (5.20–6.15) mm, maximum width across hemelytra 1.88 (1.60–2.10) mm. *Head:* width 0.93 (0.88–0.99) mm, vertex width 0.39 (0.36–0.41) mm. *Labium:* length 1.14 (1.08–1.23) mm, reaching apex of mesosternum, sometimes just extending to slightly beyond middle of mesosternum, but labrum usually reaching apex of mesosternum. *Antenna:* segment 1, length, 0.55 (0.50–0.60) mm; 2, 1.86 (1.73–2.15) mm; 3, 1.60 (1.45–1.83) mm; 4, 0.47 (0.45–0.49) mm. *Pronotum:* length 0.70 (0.63–0.79) mm, basal width 1.34 (1.23–1.45) mm.

Generally green with greenish-yellow to orange-yellow on embolium, cuneus, mesoscutum, sometimes scutellum, pronotum on calli and anterior of calli, head, antennal segment 1, extreme base of antennal segment 2, legs, and venter; black on antennal segments 2–4, apex of labial segment 4, tarsus, pretarsus; membrane of hemelytra infuscate with greenish-yellow veins; dorsum with inter-



Figures 5–13. Male genitalia of *Melanotrachus boydi*. Figures 5–7. Left paramere. Figure 5. Apex of shaft, apical view. Figure 6. Sensory lobe, apical view. Figure 7. Sensory lobe, lateral view. Figures 8 and 9. Right paramere. Figure 8. Dorsal view. Figure 9. Lateral view. Figure 10. Phallosome, dorsal view. Figure 11. Detail of ductus seminis & secondary gonopore, lateral view. Figure 12. Detail of spiculum, lateral view. Figure 13. Ventral processes of genital segment, apical view.

mixed vestiture of moderately distributed, shining white, reclining simple setae and head, anterior of pronotum and hemelytra with scattered shining, silvery, sericeous scalelike, setae (Fig. 3).

Head broadly subtriangular; clypeus moderately produced and slightly rounded in dorsal aspect, anteriorly flattened with slightly rounded ventral margin in lateral aspect (Fig. 1); posterior margin of head wider than, and slightly removed from, anterior margin of pronotum; basal carina broad, gently rounded; eyes large, height greater than head height in lateral aspect; posterior margin gently curved anteriorly in dorsal aspect; vertex width equal to $1.5\times$ width of eye. Antennal segment 1 with moderately distributed, reclining, black simple setae and two subapical black bristles; diameter about $1.5\times$ as wide as segment 2; segment 3 & 4 slightly thinner than segment 2. Pronotum trapeziform, calli slightly swollen. Mesoscutum moderately broadly exposed. Hemelytra subparallel-sided, widest at apex of embolium; length of cuneus about $3\times$ width. Venter unmarked; ostiolar peritreme (Fig. 2). Legs long; tibia with dark brown to black bristles, unmarked at base; claw (Fig. 4) gently curved with minute pulvillus and apically converging parempodium.

Genitalia: Left paramere (Figs. 5–7) broad, C-shaped, sensory lobe with truncate, broadly serrate apex; shaft broadly curved, gradually attenuate. Right paramere (Figs. 8 and 9) L-shaped, broad basally, strongly attenuate distally. Phallosome (Fig. 10) strongly sclerotized, convoluted, aperture on right aspect. Vesica with narrow elongate ductus seminis (Fig. 11) and one basally thickened, distally attenuate spiculum (Fig. 12); apex of spiculum subequal to apex of secondary gonopore (Figs. 11 and 12). Ventral processes of genital segment (Fig. 13); right process larger than left process, strongly sclerotized with flattened dorsal flange, which protrudes posteriorly beyond margin of genital aperture.

Description of Females.—Similar to males except, eye smaller, head and vertex wider, and hemelytral margin more rounded, length from clypeus to apex of membrane 5.86 (5.20–6.50) mm, maximum width across hemelytra 2.01 (1.80–2.29) mm. *Head:* width 1.01 (0.98–1.15) mm, vertex width 0.49 (0.45–0.53) mm. *Labium:* length 1.26 (1.20–1.38) mm, reaching apex of mesosternum, sometimes just extending to slightly beyond middle of mesosternum, but labrum usually reaching apex of me-

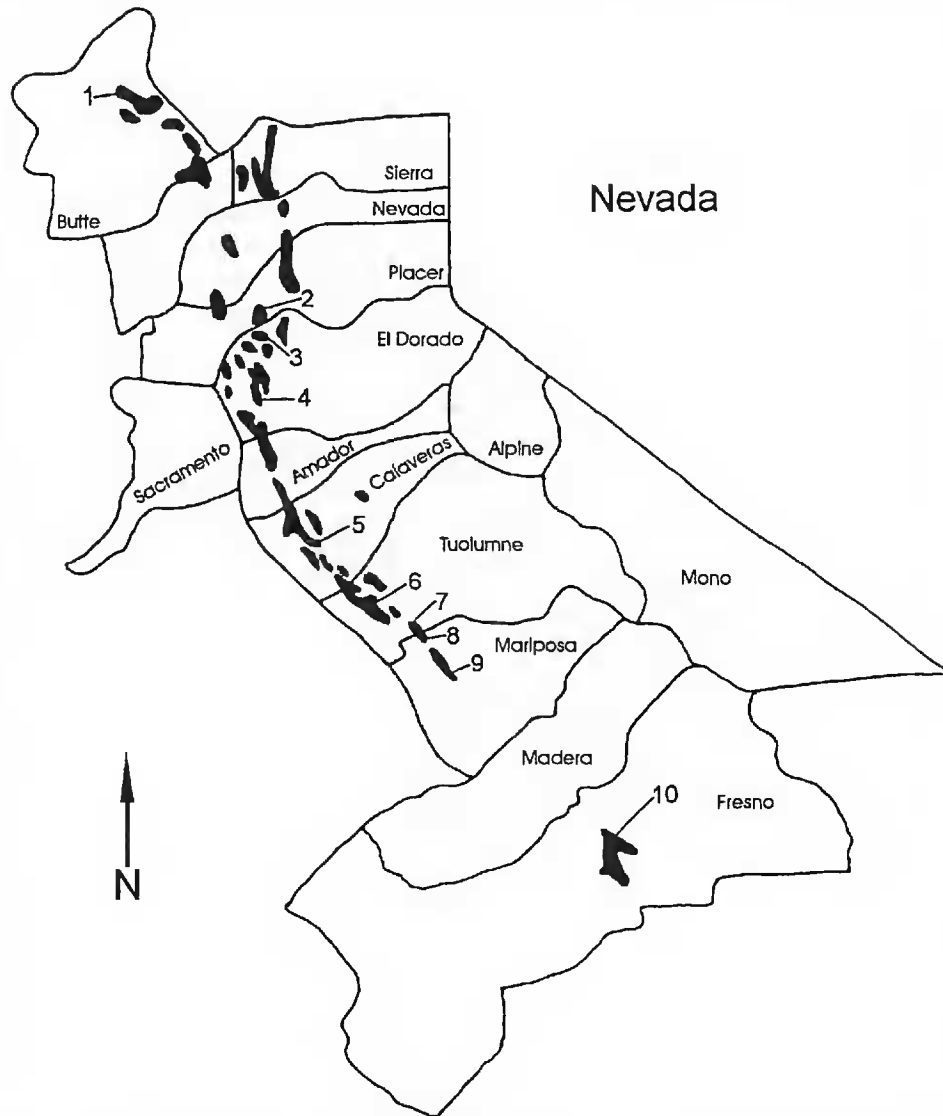


Figure 14. Distribution of *Melanotrichus boydi*. Areas filled in black represent distribution of serpentine soil within the foothills of the Sierra Nevada. *M. boydi* was either observed or collected at all numbered sites. Site numbers correspond with information presented in Table 1 (modified from Wall 1999).

sosternum. *Antenna*: segment 1, length, 0.58 (0.53–0.64) mm; 2, 1.85 (1.66–2.06) mm; 3, 1.49 (1.33–1.58) mm; 4, 0.46 (0.45–0.48) mm. *Pronotum*: length 0.81 (0.71–0.91) mm, basal width 1.58 (1.35–1.75) mm.

Diagnosis.—*Melanotrichus boydi* NEW SPECIES is most similar to *M. mistus* (Knight) and *M. stanleyaea* (Knight) in size (almost all other species of *Melanotrichus* are less than 5 mm in length) but is distinguished by the white simple setae on the dorsum, the black antennal segments 2–4, and the structure of male genitalia, especially the narrow apex of the right paramere and pointed vesical spiculum. *Melanotrichus mistus* has conspicuous black setae on the dorsum, yellow to orange antenna, and male genitalia with the apices of the right paramere and vesical spiculum blunt. *Melanotrichus stanleyaea* has similar pale vestiture to *M. boydi* but the antenna is pale, and the apex of the right paramere is longer and more acutely attenuated.

Taxonomy.—Schuh (1995) and Kerzhner and Josifov (1999) treat *Melanotrichus* Reuter as a subgenus of *Orthotylus* Fieber. However, given the absence of a phylogenetic analysis of the genus we choose to follow North American authors and describe our new species in the genus *Melanotrichus*. In Henry (1991: 455) *M. boydi* will key to *M. concolor* (Kirschbaum). In Knight (1968) this species will key to *M. stanleyaea* Knight, under *Dichaetocoris* Knight (cf., Knight 1968:

Table 1. Concentration of Ni found in sample of *M. boydi* collected at six sites throughout California (see Fig. 14). Concentrations represent values obtained from samples consisting of 15–20 individuals of *M. boydi* from each site analyzed via atomic absorption spectrophotometry.

| Site location | Ni content in ppm on dry weight basis |
|---------------|---------------------------------------|
| Site 1 | 735 |
| Site 3 | 751 |
| Site 4 | 789 |
| Site 6 | 777 |
| Site 7 | 718 |
| Site 10 | 751 |

114) or as *M. wileyae* Knight (cf. Knight 1968: 117). The black antennal segments 2–4, distribution, and host plant are sufficient to distinguish *M. boydi* from these species.

Hostplants.—*Streptanthus polygaloides* (Gray), Brassicaceae, a winter annual, endemic to serpentine soils from the foothills of the western slopes of the Sierra Nevada Mountains in California is the host of both immature and adult stages. Wall and Boyd (in press) provided evidence to indicate that *M. boydi* is probably monophagous. At ten localities where this species was collected on *S. polygaloides* they sampled other locally abundant plants—a conifer, three woody dicots, four herbaceous dicots, including other species of Brassicaceae and another species of *Streptanthus*, and a monocot—for the presence of *M. boydi* and did not collect any.

Distribution.—Figure 14. In addition to the localities listed under *Types*, *M. boydi* was also collected from the following sites in late-May to mid-July: *BUTTE Co.*: N of Magalia, 800 m; *CALAVERAS Co.*: N of San Andreas, 300 m; *FRESNO Co.*: NW of Pine Flat Lake, 400 m; *PLACER Co.*: S of Washington, 1330 m. In the western foothills of the Sierra Nevada *M. boydi* is associated throughout the range of *S. polygaloides* from Butte County in the north to Fresno County in the south encompassing a wide range of elevation (330 m to 1330 m) within the foothills woodland and the yellow pine forest plant communities.

Etymology.—Named to honor Dr. R. S. Boyd, Department of Botany and Microbiology, Auburn University, who provided insight and encouragement to the junior author during his Master's degree, and for his leadership in the study of hyperaccumulation ecology.

Discussion.—*Melantrichus boydi* is unique in several ways. Not only is it the only species of insect reported to specialize on a Ni hyperaccumulator, but it appears to accumulate Ni at levels one to two orders of magnitude higher than other insects found feeding on *S. polygaloides* (Wall 1999). This high level of Ni accumulation is concordant across the known range of *M. boydi* (Table 1). Botanists have long used a qualitative colorimetric test for identifying plants in the field that contain high levels of Ni. In this test, plant material is crushed onto filter paper permeated with the colorless chemical, dimethylglyoxime, which reacts with the Ni in the plant and changes to a various shades of red (Reeves 1992). This same test consistently gives a positive result when *M. boydi* is crushed onto the filter paper. While perhaps only having novelty status, this colorimetric test adds another interesting element to the taxonomist's arsenal for identifying this

species. At the very least, the presence of high levels of Ni in *M. boydi* is considered an autapomorphy for the species.

Including *M. boydi* n. sp., five North American mirids apparently specialize on brassicaceous hosts, all are members of the genus *Melanotrichus*. *Melanotrichus albocostatus* Knight is known from *Cardaria costatus*, *Descurainia sophia* (L.) Webb, and *Sisymbrium irio* L. Webb (Henry 1991), *M. leonardi* Kerzhner and Schuh is known from *D. sophia* (Kelton 1980), *M. stanleyaea* is known from *Stanleya pinnata* (Pursh) Britton (Knight 1968), and *M. whiteheadi* Henry is known from *D. pinnata pinnata* (Walt.) Britt. (Henry 1991). Interestingly, *S. pinnata* is a hyperaccumulator of Selenium (Brooks 1998). Determining whether or not host preference for Brassicaceae has evolved in multiple lineages, or if these five species represent a monophyletic group within *Melanotrichus* requires a detailed phylogenetic analysis, which is beyond the scope of this present study.

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